

Contribution to the Validation Static Frame Challenge Problem by using Maximum Likelihood estimators and Monte Carlo simulation.

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Abstract

Insufficient data for describing the stochastic properties of the elasticity module is provided for three data sets to be used for calibration, validation and accreditation, respectively [1]. The aim is to predict on the basis of the provided data the variability of the response and to provide an reliability estimate. It is only known that the bars and beam consists of a randomly heterogeneous material and the response is in the linear range. Beside the random heterogeneous material all other quantities are perfectly known.

The E-module will be modeled as simplified random field which requires only three parameters, namely the mean, the variance and the correlation length. As a consequence, the elongation and the E-module provided for calibration are correlated. Point estimates are obtained by the method of Maximum Likelihood which allows to consider the correlation between the elongation and the Young's modulus. Optionally, it is possible to take the measurements for the validation also into account, i.e. to improve the quality of the parameter estimates. The procedure is subsequently applied for all 3 data sets using two versions. In the first version, A, the validation data has not been considered to improve the parameter estimates, while in the second version, B, these data have been utilized after comparing with the validation data. For the validation, accreditation and prediction, respectively, the expected mean and variance of the response is estimated.

A consideration of the deviations from the mean normalized by the standard deviation, of the measured elongations for data set 1 indicates that the estimated parameters need some adjustment. These deviations, however, remain within the range which would not justify a rejection. A particularly good agreement with the estimates is obtained for the accreditation measurements, i.e. for all three data sets. The consistency with the data improves when more data can be used, i.e. for the set 2 and 3. Of course, a better agreement is achieved when applying version B, which utilizes more data, especially for the set 3 where the validation contains 10 measured elongations. To get some insight into the variability of the reliability estimation, i.e. the probability of failure, Monte Carlo simulation procedures will be applied.

References

- [1] Babuska, I., Nobile, F., Tempone, R. (2005) Model Validation Challenge Problem: Static Frame Problem. Nov. 7, 2005. Problem description as provided.